Medical Image Analysis: what and why

KU LEUVEN

The role and importance of medical images in the clinical decision process becomes ever more important. Medical imaging techniques like computed-tomography (CT), magnetic resonance imaging (MRI), echography (US) and positron emission tomography (PET) make it possible to acquire in a minimal invasive way 3D images of the interior of the body. The different modalities are based on different imaging principles and provide complementary anatomical and functional information. Interpretation by visual inspection of 3D images is often very complex due to the large amount of data and the complexity of the images and the anatomy, hence there is an increasing need for computer programs that can efficiently analyze the image stacks. The study and development of such programs is the domain of medical image analysis.

At KU Leuven medical imaging is researched jointly in the division PSI (Processing Speech and Images) of the department of Electrical Engineering (ESAT) of the faculty of Engineering Science, and the Medical Imaging Research Center (MIRC) at the University Hospitals Leuven.

Techniques & challenges

A first challenge relates to ***segmentation***. Segmentation "subdivides" the image in different organ or tissue classes. (Semi)-automatic segmentation of medical images is far from trivial because of intrinsic limitations in the imaging and the complexity of the anatomy. Promising are 'smart' models that take into account prior knowledge. Due to the natural biological variability, the model needs to describe not only the typical form of the anatomy but also the expected 'normal' variability. Training of the models is also still very cumbersome, requiring manual annotation of characteristic points in the images. More automatic methods for the determination of those points are therefore studied intensively.

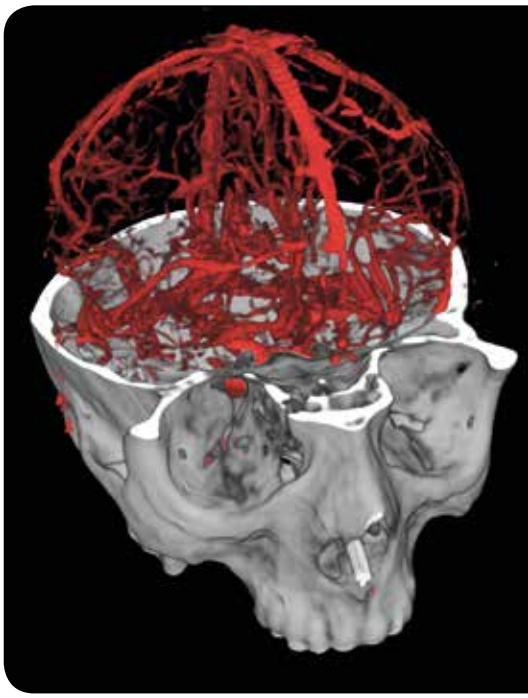
The analysis of multi-temporal and multimodal images is also a challenge. As the position, orientation, and even the shape of the patient can differ from scan to scan, robust algorithms are needed to detect the geometric correspondence between two 3D image sets. This is called ***image registration***.

Population research

Population analysis looks into group changes instead of an individual patient. The final goal is the identification of 'imaging biomarkers', being specific characteristics that are typical for a certain condition. By correlating different types of data (like, for example, genetic data) and images, personalized biomarkers can be discovered.

Realization

A close collaboration between engineers and clinicians is essential to translate new methods to clinical practice. The Medical Imaging Research Center in Leuven is trendsetting in this respect. In this interdisciplinary research center, the departments of Radiology, Nuclear Medicine, Cardiology, Neurology and Radiotherapy of UZ Leuven work in close collaboration with the engineers of the division PSI (Image & Speech Processing) of the KU Leuven. ESAT/PSI performs application-driven research on image reconstruction, segmentation, registration and visualization of (biomedical) images. The research is validated in a clinical environment in collaboration with clinicians. This way, the applicability and relevance is checked immediately, leading to a quick and efficient acquisition of new insights. This successful strategy has also led to the creation of two spin-off companies that have become international leading players. Medicim, active in the domain of digital dentistry (acquired by Nobel Biocare), and icoMetrix in the domain of imaging biomarkers. ■



For more information on the topic or the research at KU Leuven you can contact prof. Paul SUETENS (paul.suetens@kuleuven.be) or dr. Babs Weyn (barbara.weyn@kuleuven.be).

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